



# ACTIVE ENGAGEMENT AND LEARNING OF EARLY COLLEGE STUDENTS IN CLASSROOM AND LABORATORY

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## CHEM 101: College Chemistry I with laboratory - Fundamentals of Chemistry, (Credits 4)

Chemistry 101 students were taught using PPTs, White Board and Marker. The students were given regular assignments in form of homework (end of chapter questions), classwork (multiple choice questions and problem-based questions) and active learning exercises such as Oral and Poster presentations. Students were given worksheet wherever appropriate. Research based learning, collaborative learning and collective learning exercises were also employed in classroom.

Students assessment included Mid-Term and Final Examination which included multiple choice questions, short essay type and long essay type questions.

### Laboratory Exercises:

Learn the laboratory safety and procedures	Students were given a lecture on laboratory safety and procedures. After which students were shown the safety materials present in laboratory
Learn cleaning techniques of chemical apparatus	Students were demonstrated how to clean the laboratory bench and glasswares -with help of deionized water and other washing reagents as appropriate.
Learn how to measure densities of Water Oil and Salt Water.	Students were taught how to measure volume using measuring cylinder and then how to use weight the mass using weighing balance to calculate density
Learn the measurement of solid and liquid; distinguish the differences between accuracy and precision.	Students were taught the basic techniques of measuring solid and liquid. Students were also taught to generate their own graphs with the data they collected and then compare the precision and accuracy of their data.
Learn the measurement of different liquid Learn the accuracy and precision of measurement.	Students were taught how to measure different liquid using graduate cylinder. Student were also taught how to generate their own graphs with the data they collected and compare the precision and accuracy of their data.
Learn to prepare different molar NaCl solution	Students were demonstrated how to prepare NaCl solutions by weighing balance and then dissolution of salt by stirrer, magnetic stirrer. Filtration of solution with help of a filtrate and funnel. Further students were also taught how to prepare solutions of molarity of different types. Students were also taught how to calculate the amount of NaCl needed to prepare for different molar of solution by using the formula.
Learn to measure and calculate the density of NaCl Solutions by analyzing graphs to compare the differences in solution concentration	Students were demonstrated how to use a Graduate cylinder, dropper, electronic balance to record mass and volume for calculating density using the formula.
Learn to prepare working solution from stock solution by using serial dilution.	Student were taught how to perform serial dilution from stock solution with help of 2M NaCl solution, Test tubes, graduate cylinder, dropper, electronic balance. Further calculate density by measuring volume and weighing of mass of diluted solutions.
Learn how to calculate the percent mass of element to apply knowledge gained in classroom to practical life.	Students were explained how to calculate mass percentage i.e. mass to mass and volume to volume calculation.

## BIO 101: Introduction to Cell and Molecular Biology ( Credits 4)

Biology 101 students were taught using PPTs, White Board and Marker. The students were given regular assignments in form of homework (end of chapter questions), classwork (multiple choice questions and problem-based questions) and active learning exercises such as Oral and Poster presentations. Students were given worksheet wherever appropriate. Research based learning, collaborative learning and collective learning exercises were also employed in classroom.

Students assessment included Mid-Term and Final Examination which included multiple choice questions, short essay type and long essay type questions.

Learn the laboratory safety, procedures and how to use instruments.	Students were taught how to work in laboratory, follow safety procedures and how to use instruments. Students were emphasized that laboratory is the place to conduct experiment and observe cells or microorganisms. Students were introduced with laboratory rules to keep the laboratory clean and how to protect themselves while using instruments, wearing goggles, gloves, laboratory coats and fire extinguisher all the times when working in laboratory.
Learn to use microscope, parts of microscope and functions.	Students were explained the parts of microscope with Aid of White Board and PPTs. Further with help of pointer students shown parts of microscope and demonstrated function of parts of microscope. Students were given worksheet to label the parts of microscope. Students were further explained with help of white board and marker how to calculate magnification.
Learn how to view permanent slides under microscope.	Students were demonstrated how to use a microscope to view permanent slides and calculate magnification.
Learn how to prepare and view temporary slides under microscope.	Students were demonstrated how to prepare and view onion and cheek slides with help of onion peel . cheek cells, glass slide, microscope slides and stain. Students were further asked to calculate magnifications at low, medium and high power and further to compare the magnification as well as size of cells.
Online Virtual laboratory by Howard Hughes Medical Institute (HMMI) on How We Get Our Skin Color	Students first watched how human skin cells produce the pigment melanin, which gives skin its color. The animation included major information on what produces the melanin, how do these pigments protect the nucleus.
Learn how to read, write and understand a scientific paper.	Students were demonstrated how to explore research articles via NCBI PubMed and Google Scholar etc . Further how to read a scientific paper by following IMRAD format which is significant in learning science, especially when trying to find specific information. Students were given worksheet to write about the chosen article to understand the science included in the article.
Online Virtual Laboratory by HMMI on Bacterial Identification.	Students performed this online laboratory to follow series of stages on how to identify bacteria by using technologies and equipment such as PCR and gel electrophoresis.
Group Based Learning. Exercise on Design an Experiment to make a Heterologous Protein.	With help of white board and marker students were explained the process of cloning and production of protein. Further students in group were asked to discuss the process of protein production.

Learn about Bioinformatics by HMMI	With the help of white board and marker students were explained what bioinformatics is and were asked to explore the NCBI PubMed to evaluate the DNA sequences. Further students watched HMMI videos on Human Genome Sequencing, Shotgun Sequencing and by doing exercises on DNA Sequence Assembly and Creating Phylogenetic trees from DNA Sequences to get a better understanding about Bioinformatics.
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#### BIO 102: College Biology II with laboratory– Organisms and Populations (Credits 4)

BIO 102 Students were also taught by employing White Board-Marker, PPTs and active learning Exercises. Students were actively engaged in below exercise:

1. Group Based Learning Exercise on Cell Cycle- Students taught what the different parts of cell cycle- interphase, prophase, metaphase and anaphase. Further students were shown an image of a tissue in which cells were in various stages of cell cycle – students were asked to identify the stages of cell cycle , count and calculate percentage of cells in a particular phase of cell cycle. Students were asked to explain the observations and further asked to explain a complete phase of cell cycle.
2. Collective Learning- Students were explained what a phenotype and genotype. Students were shown images of different phenotypes and were asked to explain the genotype. Students were also asked to calculate the homozygous-heterozygous ratio after identifying dominant and recessive genes.
3. Stump your partner, Think-Pair Share and Write Pair Share and Students were asked to think of a question pertaining to cellular respiration further students asked questions to their partner and then in pair thought of an answers to share with others and finally wrote the answer which was shared with others students.
4. Multiple Choice Clicker Questions, Interactive Discussions and Minute Type Papers- Students were challenged with multiple choice questions pertaining to evolution to assess their understanding. Students were further given a topic to discuss to further explore understanding of speciation. To further assess their understanding students were asked to write a minute paper on speciation.
5. Catch Up and One Sentence Summary- Students discussed their notes with their group members and further updated their notes. Students were asked to explain a specific topic on evolution in one sentence.
6. Concept Mapping- Students individually, in group and collectively mapped the notes for Unit I and Unit II
7. Muddiest Point – Students were individually asked to think and share the most important learning in classroom.
8. Fish-Bowl Debate- Students were given a topic to debate on evolution. Students were divided into three groups; the first group was given a topic on advantages of evolution. second group were supposed to listen to both the groups and third group was given a topic on evolution to explain disadvantages of studying evolution

#### Laboratory Exercises:

Learn the laboratory safety, procedures and how to use instruments.	Students were taught how to work in laboratory, follow safety procedures and how to use instruments. Students were emphasized that laboratory is the place to conduct experiment so following safety rules will help further. Students were introduced with laboratory rules to keep the laboratory clean and how to protect themselves while using instruments, wearing goggles, gloves, laboratory coats and fire extinguisher all the times when working in laboratory.
Learn to use microscope, parts of microscope and functions.	Students were explained the parts of microscope with Aid of White Board and PPTs. Further with help of pointer students shown parts of microscope and demonstrated function of parts of microscope. Students were given worksheet to label the parts of microscope. Students were further explained with help of white board and marker how to calculate magnification. Students were also shown JOVE Science Education video on Fluorescent Microscope.
Learn how to view permanent slides under microscope.	Students were demonstrated how to use a microscope to view permanent slides and calculate magnification.

Learn how to prepare and view temporary slides under microscope.	Students were demonstrated how to prepare and view onion and cheek slides with help of onion peel . cheek cells, glass slide, microscope slides and stain. Students were further asked to calculate magnifications at low, medium and high power and further to compare the magnification as well as size of cells.
Learn what is Osmosis	Students were demonstrated Osmosis in Elodea Leaves at different magnifications and then magnification was calculated at low, medium and high power. Students learned the process of osmosis.
Learn how to read, write and understand a scientific paper.	Students were demonstrated how to explore research articles via NCBI PubMed and Google Scholar etc . Further how to read a scientific paper by following IMRAD format which is significant in learning science, especially when trying to find specific information. Students were given worksheet to write about the chosen article to understand the science included in the article.
Learn what is Geological Time Scale	Students were given a worksheet to construct a geological time scale with help in laboratory. Students in group prepared a the Geological Time Scales and further were given worksheets to practice geological timescales on Deep History of Life on Earth and Geological History of Oxygen , Geological History of Carbon by HMMI.
Virtual Laboratory to learn what is Cell Cycle	Students were shown HMMI videos on Cell Cycle and were given worksheet to assess their understanding and further a click and learn activity on The Eukaryotic Cell Cycle and Cancer. Students were able to compliment and practice theory in laboratory. Students were given another online laboratory wherein they were asked to identify and compare the different phases of cell cycle in normal and cancer cells.
Virtual activity on Energy in a Cell and Respiration by McGraw Hill and Cellular Respiration by SimBio	Students were given an online laboratory activity to understand how energy is produced in a cell and respiration occurs in a cell. Further another activity on cellular respiration by SimBio was performed by students to understand the process of formation and metabolism of ATP.
Learn about anatomy and life cycle of Bryophytes Learn about Flowering of plants: Tulip anatomy and life cycle Practice Hardy Weinberg Equation	Students performed online virtual laboratory exercises to understand the structure and flowering in Bryophytes and Angiosperms. Students were shown videos as well to comprehend understanding of parts & life cycle. Students also dissected the flower and prepared slides of pollen grains. The students were demonstrated how to prepare the pollen grain slides. Students also applied Hardy Weinberg equation to calculate the frequency of genotype of diversity of flowers on campus.
BioBlitz by National Geographic Channel	Students were asked to perform a field-based activity to observe, record and identify the flora and fauna on campus and then identify the genus and species of the organism using I-Naturalist.
Bio-Statistics	Students were taught the basic statistics through white board and marker, completed a worksheet. Students were given a tasks to further collect the leaves on branches of various plants and were asked to apply statistics to calculate mean, median and mode. HMMI online activity was also explained to students to learn the various statistics test of significance and variation.

#### BIO IND: Independent Study in Stem Cell Biology (Credit 1)

Students were explained the topics pertaining to Stem Cell to be included in your research report. Students met weekly to discuss the research articles and were also explained some concepts in Stem Cell Biology with help of White Board and Marker. Students were also explained how to read and write a scientific article. Students summary was marked, and feedback was given every week. Students were given weekly active learning exercises and was also taught how to write scientifically and to project the papers to be interdisciplinary in nature.